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ABSTRACT

The first (exploratory) phase of the Learning in Science Project focused on science teaching/learning in the Form 1 to 4 level (ages 10 to 14) and sought to identify problems and difficulties in several areas. Provided in this paper are comments obtained during structured/unstructured interviews (from students, ex-students, teachers, headmasters, science advisers, and inspectors) and observations made by project staff related to student attitudes. The intent in presenting these comments/observations is not primarily to provide a balanced view of the good and bad aspects of Form 1 to 4 science, but rather to open up problem issues as project staff and others see them. Issues and problems addressed by the comments/observations focus on: (1) use(s) of the term "attitudes," differentiating between attitudes to science, interest in science, and scientific habits; (2) students' attitudes toward and interest in science, considering male/female, ethnic, and age-related differences; (3) development of positive attitudes and interests, indicating that two important factors in this development are providing successful experiences for students and teacher enthusiasm/interests; and (4) the relationship between development of scientific habits and teachers' interests in and attitudes toward science. Major points are highlighted in a final summary section. (JN)

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LEARNING IN SCIENCE PROJECT

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FOCUS ON ATTITUDES

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WORKING PAPER No 9

The Learning in Science Project is an educational research project undertaken at the University of Waikato under contract to the NZ Department of Education. The project is initially investigating the problems and difficulties of Form 1 - 4 Science (10 - 14 year olds) as a first step to improving teaching and learning.

This paper is one of a set of essays which is an outcome of the exploratory phase of the project. It is our hope that feedback from these essays will assist further to clarify issues and assist us in establishing priorities for the in-depth phase of the project. Any comments our readers have on either the issues involved, or the methodology adopted in these papers, would be most welcome.

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A WORKING PAPER OF THE LEARNING IN SCIENCE PROJECT

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November 1979

This is one of a set of discussion papers which focus on various aspects of Form 1-4 Science. The paper collates comments and observations, related to the topic of focus, which were obtained during the first phase of the Learning in Science Project. In this phase we were particularly concerned about problems and difficulties in Form 1-4 Science and because of this the paper is biassed toward issues as identified by pupils, ex-pupils, teachers, headmasters, science advisers, inspectors as well as by our own observers. Our intention in writing the discussion papers is therefore not primarily to provide a balanced view of the good and bad aspects of Form 1-4 Science but rather to open up problem issues as we and others see them, to a limited but wider audience than the project team.

It is our hope that our chosen readers will be prepared to talk to us about the topic under focus in this paper in terms of the following questions:

(i) Are the issues we have raised important and central issues which are of general concern?

(ii) Are there other more basic issues, or other subsidiary questions, about the topic which we have overlooked?

(iii) Which aspects of the topic could we profitably analyze further in the in-depth phase of the project?

(iv) What possible solutions to some of the issues raised could profitably be the subject of further study?

INTRODUCTION

Positive attitudes to science have been considered important objectives for science education for a long time. For example, Jean Jacques Rousseau in his Emile states :

> "It is not a question of teaching him the sciences, but of giving him a taste for them, and methods of acquiring them when this taste is better developed. This is most certainly a fundamental principle in all good education." [1]

A somewhat similar emphasis can be seen in the draft F1-4 Science syllabus, which begins with the observation that science has three main aspects :

a set of attitudes to inquiry;

a method of inquiry;

a body of knowledge.

One of the problems in discussing attitudes, however, is that the word is used by teachers in a variety of ways. For example, some use the term to indicate an interest in, and enjoyment of science.

41/2/2 "It's hard for me to try and put across a positive attitude towards it [science] - I know that because I've got a negative attitude towards it - anything science."

[Intermediate teacher]

Others tend to view it more in terms of motivation and work habits.

38/7/1 "I really can't see any differentiation between their [the pupils'] attitude to science to really anything else - not in my experience anyway. They're just as keen or just as anti-science as they are anti anything else - they're as keen as anything else."

[Intermediate teacher]

Others use the word attitudes to describe those predispositions which scientists might be expected to have, as does the draft syllabus :

25/15/2 "When you look at attitudes, in fact a lot of them have got something to do with process or instrumental skill as well. There is one there - a precision of measurement - the limitations of measurement. So it is not strictly attitudes."

[H.O.D. Science]

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[1] Boyd, W. (1956) Emile For Today p.77. London, Heinemann

25/15/1 "I must insist that the kids explain the unexpected results, I have got to question the genuineness of data, if it fits the ideal thing too closely and that sort of thing. And if my programme allows for that I have got a programme that will help - that is consistent with the good attitude. But if I am telling the students what the results are and what conclusions they should get from those results in some way, or if I ignore results because they don't fit the pattern, or say that those results are wrong or no good, then I am setting up a situation that is consistent with a bad attitude as far as data is concerned."

[H.O.D. Science]

On the other hand some teachers tend to refer to attitudes to work as
23/11/3 process skills. For example, one teacher told us in discussing the evaluation of such skills, that his list emphasized concentration, cooperation, reliability, and initiative. We have restricted the term 'process skills' to specific skills of inquiry, observing, measuring, classifying, designing an investigation, drawing conclusions, and so on. These are discussed further in FOCUS ON PROCESS SKILLS.

We have found it convenient to distinguish between 'Attitudes to science' such as enjoyment, satisfaction; 'Interest in science' such as motivation towards the study of things scientific; and 'Scientific habits' such as open-mindedness, intellectual honesty and objectivity.

The first two distinctions are often closely related, but it appears possible to enjoy science, as it is taught, without developing a real interest in it, and, conversely, to be interested in things scientific without gaining very much enjoyment or satisfaction from them.

With regard to the third distinction - scientific habits - can these be gained without a positive attitude toward science, or without a real interest in science? Can they be developed in a student who does not identify positively with the subject?

PUPILS' ATTITUDE TO AND INTEREST IN SCIENCE

The following quotation, a lengthy one, clearly identifies the usage of the term 'attitude'to cover the first two distinctions noted above, and provides a rarely expressed analysis of how such attitudes may be developed.[2]

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[2] Note : It is accepted - but infrequently expressed - that both pupils' and teachers' attitudes to science should be positive.

17/8/1-2 "We're dealing with a very important area in science because as I see it we're going to develop attitudes. Attitudes of work, which is very very important, and attitudes to a particular subject. Now, what bothers me is that if the teachers don't take their teaching seriously, unfortunately very poor attitudes develop - attitudes of work and attitudes towards a particular subject. And so often I get the comment from third formers before I've even taught them, 'I don't like science', or 'I hate science', that this stems from the fact that they've met with no success in the subject. Now, if they can succeed in a subject they begin to like it. As an analogy - a person who is very poor or very bad at tennis rarely plays tennis - he has no interest. The person who is good at it was the interested person and he succeeds. Now, how we measure success - well I measure success towards any subject purely from the attitude of the pupils towards the subject. If they enjoy it, if they like it, I measure that in terms of success. In other words they're succeeding and they're gaining from it. And I feel that if a teacher in science ensures that what he teaches is understood by the pupils and it involves the pupils in practical work - we must always test. If he tests in that particular area then make sure the tests are within their capabilities so they gain success, then they develop the right attitude towards the subject."

[Secondary teacher]

We usually asked of the pupils "What do you think of science? Do you enjoy it? Why (or why not)? etc". A wide range of answers were offered. Most pupils did like science, at least initially, and qualified their responses with comments like :

65/1/3 "Well, I simply enjoy it more [than other subjects] because there's a lot more activities involved."

[Intermediate pupil]

29/1/1 "I like doing experiments."

[3rd form pupil]

7/4/1 (also 20/1/2) "Biology I can remember that really well... really enjoyed that at primary school...I can remember spending hours over my bio.assignments and things."

[ex-pupil]

20/24/1 "Last year [science] was fun because we did mostly experiments. The year before that all we did was write - it was boring."

[Form 3 pupil]

65/1/3 "I didn't like the writing up of experiments but everything else was just good."

[Intermediate pupil]

However, some lost interest in science for various reasons,

13/3/2 "It just started to get beyond me...it was just that it was all very dry and mathematical and I just switched off."

[ex-pupil]

15/3/2 "At the beginning of the 3rd form it was something pretty new and the labs looked pretty impressive and that sort of thing... but we didn't enjoy it much or anything throughout the year... we had a pretty negative attitude towards it. (What caused that?) I think it was because just sit down and learning. You don't participate much...and it was pretty hard to grasp some of the things they were giving us...they were pretty new... and then we have tests and exams and fail everything."

[ex-pupil]

15/2/1 " In the 4th form it was trying to work out equations and I used to get really sick of that... and I didn't take anything in I don't think."

[ex-pupil]

15/7/2 "In Form 1 I did think that I would like it...I did think it would be interesting...(and what was your attitude in 4 Form?) Oh it wasn't very good."

[ex-pupil]

Then there is the difference between enjoying science and doing well at it.

12/6/1 "I enjoyed science but I never got particularly good marks in it. It just wasn't my line of work really...It didn't mean anything to me. I didn't need it...I was more interested in other things."

[ex-pupil]

43/4/2 (What do you remember of science at school?) I didn't need it. Science was the worst subject out of the school I reckon. I didn't need it. (How do you mean you didn't need it?) I didn't need it to get the kind of job I needed...I enjoyed doing the experiments... it was fun...but when it came to the theory I didn't like it."

[ex-pupil]

Some group differences

Different attitudes to science within groups of pupils were readily observed.

(i) Male-female

25/8/2 "The girls generally seem to be more interested in the biological sciences and the boys generally seem more interested in the chemistry... but I have never really found that either one or the other is more or less interested in the physical side of things."

[Secondary teacher]

74/4/2 "A lot of guys don't like biology and yet girls do and yet they don't like science in general."

[ex-pupil]

41/8/2 "At this age [Intermediate school] I'd say boys were more interested in that sort of thing [Science] ... They [boys] like we brought praying mantises back and they just loved catching flies for it and watching it eat you know...It was their big thrill for the day you see but the girls weren't interested in that."

[Intermediate teacher]

74/10/3 "Guys don't seem to be much interested in English so they wouldn't be very much interested in Bio - there's too many essays and big long words don't help."

[ex-pupil]

17/21/1 "At the moment their attitude...I don't know whether this is to school in general or whether it is just to science...is fairly anti attitude...particularly the girls, they are very scatty... interested in getting up the back and talking rather than working... its a 4th form syndrome...it's typical."

[Secondary teacher]

(ii) Ethnic differences

28/7/2 "Last year I took Form 2, I had more Maori - probably about 50% and the attitude there was a lot less than I think the attitude of the Pakeha. But I think this year when I've got about 30% I think the attitude of the Maori children I've got in there is higher than the Pakeha children. My top boy and girl in the room are both Maori children whereas last year the bottom boy was Maori - the top ones were Pakehas. I can't account for that all really."

[Intermediate teacher]

40/4/3 "I've noticed that they Maori and Island pupils turn on quick and they turn off quick."

[Intermediate teacher]

26/2/1 "You find the Polynesians are not always as well motivated as the Pakeha...they don't seem to be able to be on the same topic for long...they get excited about it and suddenly they lose interest because you have been on it far too long...they want to get on to something else."

[Secondary teacher]

(iii) Age related

83/8/3 "It was quite a shattering to me...the children's attitude to science...how enthusiastic they were."

[Form 1 teacher]

40/7/3 "Taking science with standard one is a joy because they're so enthusiastic - you know - if your seed starts to sprout - they jump up and be in and all the rest of it - they think it's really wonderful - if the teacher is lacking in confidence - standard one or two is a good lot to take because they get so wrapped up in it... It [science needing to be relevant] wouldn't be as much a problem here as it perhaps would be at high school because their enthusiasm is still there and they're a wee bit less inhibited about finding out for the purpose of finding out only."

[Intermediate teacher]

83/2/3 "...at form one and two level - you get the science nuts and kids that love science - all their non-fiction books that they take out of the library are science books - experiment at home - they've got menageries ofbugs that they look after."

[F1-7 teacher]

Compare these comments with the one made earlier.

17/21/1 "..their attitude...is a fairly anti-attitude...it's a 4th form syndrome."

[Secondary teacher]

If there is a change of attitude, when does it occur?

39/5/3 "The kids were still keen [after doing a unit of work] which I thought was really good...especially at this age because these kids are starting to get turned off [science]."

[Form 2 teacher]

35/1/2 "[In many cases] it is all very teacher-structured...demonstrations, lecture type - where the kid takes down screeds of notes..goes home and learns them and regurgitates them...so usually by the end of the 3rd form, if they last that long, they have got a thorough dislike for science."

[Science inspector]

Let us now turn to comments about how positive attitudes to science and an interest in science might be encouraged.

THE DEVELOPMENT OF POSITIVE ATTITUDES AND INTERESTS

In terms of the views which students have expressed to us, positive
13/2/2 attitudes to science, and to doing science, seem to depend a great deal on pupils having success experiences. This view was expressed in the first quotation in this section and has been reinforced by others.

12/6/3 "I didn't understand a fair bit of it...which is why I felt I didn't need it."

[ex-pupil]

79/3/1 " That they know that they are achieving that's important for half of my class."

[Form 2 teacher]

74/5/2 "People get turned off Physics for a start because they are told its the hardest one."

[ex-pupil]

58/9/2 "If a kid knows what you want him to do and how to do it... he will do it...and if he is doing it he won't ask why... he is quite happy and he will enjoy it."

[Science inspector]

63/7/2 " One ex-pupil remembers clearly the day he got an answer correct! He remembered that because he got personal satisfaction that day."

[Primary inspector]

8/7/2 "People who find that they are successful at doing a particular thing enjoy doing it usually...you need to design practical experiences, problem solving experiences, where children can cope with, and get satisfacation out of being successful."

[Secondary teacher]

Both teachers and pupils have commented on the inherent insecurity in the way much science is taught and we made comment of this above. Thus, if positive attitudes are related to security and success then we need to consider very carefully how and what we teach.

41/1/3 "The children are supposed to discover...and I think it makes children insecure in a lot of cases...they don't really know what is expected of them...what sort of answers they are supposed to come up with...and I think nine times out of ten the child likes things in black and white...you know...I used to anyway and still do."

[Intermediate teacher]

24/1/3 "Physics was the worst as far as experiments...we'd get a vague thing...do this and we had to do it and find out...discover ourselves and I didn't like that."

[ex-pupil]

Also, good management, control and pupil instructions relate to good attitudes as well,

12A/1/3-2/1 "I was scared the meths burner would blow up - someone would knock them on the floor - (You were apprehensive about the equipment?) - I thought I might break it - hurt myself or something - scared I would drop a test-tube which I did do once...Yes and acids and things - we were always being told they'll burn you and you know and people would chuck things around when the teacher was

out of the room and I didn't like it really - or put bits of acid on you so you'd burn holes in your clothes."

[ex-pupil]

40/6/2 "It was two girls who said they're not going to muck around with any burners or anything that's going to burn or blow up."

[Intermediate teacher]

On the other hand, the importance of teacher enthusiasm and interest cannot be under-rated in the development of positive attitudes and work habits.

70/3/1 (also 12/1/1) "(You said you liked science last year?) Last year I was with my mates and we used to have fun - we used to take it seriously because we had a good teacher. (You took it seriously and had fun?) Yeah - you'd do something and then you'd stop and the teacher would tell us a joke and then we'd laugh and then we'd carry on - we were allowed to talk and move about - we'd still get our work done - what we didn't get done we'd do for homework and show him the next day. You know you'd just enjoy yourself. (You worked hard then?) Yeah - this year you're not allowed to talk, move. (Did you understand last year?) Yeah - most of it."

[4th form pupil]

7/2/2 15/6/2 "I think the teacher can make you like or dislike a subject early on - you know it's how they tackle it really."

[1st year T.C. student]

83/15/2 "I don't think you can teach anything you are not enthusiastic about."

[Form 1-7 Science teacher]

20/5/1 41/25/2 42/9/3-10/1 "The most important thing for the pupils, or should I say the lower half of pupils, is the teacher. They are far more concerned with their relationship with their teacher than they are with their relationship with the subject. For the brighter kids it can go almost the other way - amongst the real enthusiasts - but they are a minority. At least half the students - as long as they get on with the teacher, then they get through in science. You ask them 'what do you think of science?' and you invariably get back a comment on what they think of the teacher."

[HOD Science]

41/6/3 "I think the teacher being enthusiastic more would help a lot... to develop their [pupils'] liking for the subject...I think if you [the teacher] can show enjoyment to the kids - the kids will enjoy it too."

[1st year teacher]

8/7/2 "Just how much satisfaction do kids get out of doing science in Form 3 and 4...if they get a lot of satisfaction they will go on and do science...I am wondering if we can develop technqiues which will in actual fact help children develop satisfaction in science."

[Secondary teacher]

Does the following teacher need to say more?

42/13/2 "(Do you find kids have the right attitude to science?) Well I find it fascinating..."

[Intermediate teacher]

Another teacher expresses it similarly:

14/17/3 "I think if you can show enjoyment to the kids they will enjoy it too."

[Intermediate teacher]

Several teachers commented on their own feelings on the teaching of science:

41/3/2 "You have to be an exceptional teacher to get science across I reckon - because basically - it has always been boring to me - it always been really boring you know - and you have to be really on the ball or really enthusiastic yourself to get it across."

[Intermediate teacher]

38/10/2 40/2/1 73/2/2 41/1/2 41/3/2 "The science units that I really enjoyed are the natural science units. The ones to do with animal communities, pollen study, mud flat studies - because I feel that there's more than I can offer the kids in those areas. I suppose my knowledge is greater... I did biology [at secondary school] - I suppose that's why I like [te hing] those natural subjects."

[Intermediate teacher]

One teacher has commented on other teachers' feelings:

24/7/3 "The majority of primary teachers [including intermediate] now are women. And they do not like physical sciences because they are frightened of it."

[F1-4 Science teacher]

The development of a real interest in science appears to require more than just the teacher's own enthusiasm and interest in his subject. Several students have commented on the perceived relevance, or otherwise, of science to their everyday world (or experiences) and how this influenced their interest in science.

16/2/1 "I could identify more with Biology...see in the environment there are things that you can identify with...more than the physics side...you'd go out into the environment and you'd say oh well that - you can relate it to what you are doing at school ...its more interesting and that is probably why I'm more interested in Biology."

[ex-pupil]

13/5/1 "If we had done things in class that would relate to what happened everyday that would have made it a lot more interesting...I mean some of the things like light and how light travels...you can apply it but not as directly as you can other things...like if you are studying biology and you learn how plants grow well that's more interesting 'cause you can look out the window and see trees growing and you understand better."

[ex-pupil]

Alternatively how can you develop a real interest in an activity, even if you do enjoy it, when it appears not to be related to anything or seems to have no purpose?

13/5/3 "I can relate Biology more to things around really...I mean things like in Physics, how when we push something and it hits something - well O.K. it does it...so what?"

[ex-pupil]

Teachers too, have commented on the relationship between interests and relevance,

21/12/3 "we are expecting that they will be interested in everything that we do however quite a lot what we do doesn't relate very directly to outside experiences..so they can't see in a number of things where it is really fitting in for them".

[P.R. Junior Science]

17/4/2 "We just carry out the experiments that have been set down in the books and they often don't really relate to the outside world."

[H.O.D. Science]

and possibly many teachers don't, or can't, relate them either.

35/7/2 "I think a teacher often deals with a topic for the sake of a topic rather than relate it to everyday life which is easy enough to do...but teachers [in the main] I don't think do it".

[Science inspector]

Is it easy enough to do?

22/5/2 "..rather than have a bottle labelled sugar free starch, we should get a bit of mashed potato."

[Science teacher]

8/15/1

"..having been out of teaching for a while I was able to see a large number of applications [of the science in education] and it is quite a frustration to realize that in N.Z. there are these enormous resources that the DSIR have and say the Ministry of Works, Ministry of Energy, Internal Affairs, conservation people...it would seem to me to be a matter of very small expenditure to appoint five or six former teachers to the task of disseminating this material on a short term or permanent basis."

[Teachers College lecturer]

Having pointed out a possible relationship between interest and perceived relevance, let us finish this section with a quote from a retired science inspector. We suspect many would not agree with it but it is an alternative viewpoint!

58/8/3

"One of the misconceptions which has grown up in education I feel, is that kids have been encouraged to believe it matters... that if it is not directly relevant to the kids'past then it is not good..and I think that is bloody nonsense quite frankly... I think any valuable education must be irrelevant to a kid because it is for his future not his past...now this is the thing that has not been sold to kids for years..the reverse has.. the kids have been encouraged to say what has this to do with me yesterday...you [should] say to kids this is interesting because you may need it any time in your life...I am still unrepentant that the point of educating a kid in science or anything else is to say..look here are a series of interests...a series of values...a series of opinions which may be of value to you later on...may be of interest to you later..may help you form opinions later or may not...but they certainly fascinated me...[the answer] to keep a kid interested is to keep him busy ...if a kid knows what you want him to do and how to do it...he will do it...he will not ask why...he is quite happy and he will enjoy it....never mind explaining to a kid why this might be useful to you later...show him how to do it...get him doing it and what does he want to do? ....more of it...there is no problem about keeping him interested although it is utterly irrelevant in his words....[a teacher's statement that] he can't get a kid interested is confession that he is not keeping the kid busy...I don't blame him.. it's a hell of a job."

[Science inspector]

SCIENTIFIC HABITS

Scientific habits have been disucssed in other working papers such as FOCUS ON EXPERIMENTS and FOCUS ON PROCESS SKILLS. In this section emphasis is given to the relationship between the development of such habits and the teacher's interest in and attitude towards science.

Few teachers we spoke to commented to us about the explicit teaching of scientific habits. This is a rare example :

20/7/2

"This business of being prepared to question just established

ideas is a very hard one to get across to them. So it is
20/7/2 something you have to keep at all of the time with that level [lower ability] kid...being prepared to question what they see on T.V.[for example]."

[H.O.D. Science] [to question]

Many teachers seemed to believe that their students developed scientific habits simply by being immersed in science, particularly in experimental, practical, or field work.

"To me a science is a fairly exacting business and the kids
73/1/1 learn to do an experiment - they learn to write it up so that they can learn to take systematic observations of what they're doing."

[Intermediate teacher]

25/19/3 "Some kids do things, but they don't really know why they are doing it. And they don't really know where they picked up this particular skill or this particular approach to something. It is just something that happened."

[H.O.D. Science]

12/11/3 One possible consequence of this lack of emphasis on explicit
12/12/2 teaching for the developing of scientific habits, is that the very antithesis of good scientific habits may be developed. For instance,
12/15/3 some of the problems of 'discovery' methods of teaching and learning have been discussed in FOCUS ON EXPERIMENTS. Such methods can result in students becoming fearful of not getting the right answer.

73/5/3 " [With the discovery approach] kids that I would normally have regarded as quite good at science are not achieving what they should be achieving...instead of achieving and moving on and doing very well, they become apprehensive."

[Intermediate teacher]

Children can acquire various anti-scientific habits in coping with this problem. For example, an ex-pupil comments:

"By the time the fifth form - fourth to the fifth form - we
74/12/2 know what we were doing [in practicals] - sort of knew what we were doing - what the general idea of it - even if the answers we had had to be cooked to be made right... He [the teacher] didn't like us cooking the answers but we did it because it was easier explained why it worked than why it didn't work by analysis - it's all right having errors - you know you work out so much here - so much there but a few miles out - obviously you've done something wrong and you get someone who's done the experiment right and just sort of change it a little bit just so it suits that sort of thing."

[ex-pupil]

Perhaps this obtaining of the 'right'answer is tacitly condoned by some teachers since the explaining of spurious results is often very difficult - particularly for the non-specialist teacher. This explanation is supported by an intermediate teacher's comments:

40/5/3
(also 24/8/2)

"If it's an experiment say and it goes wrong - and it's happened to me in science - O.K. why did it go [wrong] ? Then you see the kids don't know its going wrong because you really haven't told them what is supposed to happen and you can cover it up of course - just do it again - but if the kids know what is supposed to happen because in some things it is obvious what is going to happen - and it doesn't - then you've got another problem - why did it go wrong?"

[Intermediate teacher]

One HOD Science suggested that this phenomenon of searching for the 'right' answer is as a consequence of science experiences received earlier.

25/19/2

"I would say the form one and two science seems to impress on these kids that there are right answers for things - that they are concerned with what is supposed to happen because there has got to be a right answer."

[HOD Science]

Perhaps some teachers themselves believe only the one answer is tenable for a given experiment or problem?

35/5/3

"...I am always worried when I hear people talk about the right answer or the wrong answer for an experiment...I think anyone who talks along these lines wants to look very closely at what he is doing...There is a tendency to rubbish kids [who do not get the answer to support the theory] instead of looking at the answer and saying O.K. these all agree and this one is different... now why is it different? It might be carelessness and it probably is...but that's a learning situation...but I think this where the basic fault in our teaching comes that things are black and white and they are so concerned with the theoretical aspect they lose complete sight of why they are doing practical work."

[Science inspector]

It would seem to us that perhaps one of the problems in developing scientific attitudes is a lack of real appreciation of the nature of science by many teachers, particularly those without formal training in science and even possibly by those science graduates who have had no research component in their degrees. Can teachers develop good 'scientific habits' in their pupils if they are not aware or sure of what these habits are?

35/10/1

"I think enough of your trouble in science is coming from those

teachers who have no strong scientific backgrounds... they hear a lot about theory...they hear about the corpuscular theory or wave theory of light and this is correct, this is true! and everything is matched to the theory...the theory is not there to explain experimental fact...I saw a teacher [recently] say 'you got the wrong results' and I looked in horror at him... I pointed out to him, I said ' they got the right results' you are using the wrong theory to explain the results but he wouldn't agree with me! The kid had the correct result if you used the appropriate theory but to the teacher there could be only one thing that was right."

[Science inspector]

41/16/2 "(What do you think of the scientific method?) Well to tell you the truth I am not sure what you mean."

[Intermediate teacher]

The final point that needs to be made in this section is that the pupils (as well as the teachers) need to see that science is a human, not a super-human, endeavour if they are going to develop competence and confidence in doing science, and to appreciate scientific activity.

42/14/1 "[That theory of how valleys form] is gospel truth as far as they [the pupils] are concerned and to put across to them that this is a group of people's thinking!....it took quite a lot of discussions to get that idea across to them."

[Intermediate teacher]

20/7/2 "I don't try to get them [lower ability kids] to believe they can understand everything [but] even if they don't understand it themselves they can [be taught to] see that somebody else whose got a greater knowledge of these sorts of things can find a logical explanation even if they can't. They get incredibly hung up on some pretty way out theories."

[H.O.D. Science]

SUMMARY

To enable the reader to 'focus' on the issues raised by the comments in this paper, a list of points made in the various sections is provided.

(a) Attitude to science and interest in science

- many pupils prefer laboratory work to writing, although some pupils don't like apparatus and chemicals,
- on average girls prefer biological topics while boys prefer physical and chemical topics,
- there are equivocal differences between Polynesians and Pakehas,
- younger students seem to have more positive attitudes and interests.

(b) The development of positive attitudes and interests

- some pupils and teachers perceive positive attitudes to be related to success experiences as well as good classroom management and control,

- teacher enthusiasm is seen as an important factor in terms of developing a positive attitude toward science as well as an interest in science,

- some pupils and teachers associate the development of pupils' interest in science with the development of an appreciation of the relevance and purpose of science.

(c) Scientific habits

- scientific habits do not appear to be explicitly taught by many teachers,

- some aspects of the learning environment may well encourage poor scientific habits,

- it is suggested that the encouragement of good scientific habits necessitates a sound appreciation by teachers of the nature of science.

In this paper we have attempted to suggest in terms of teacher enthusiasm, pupil success experiences, and pupil appreciation of the importance of science, how the emphasis by the draft syllabus on attitudes might be transferred to the pupils in the laboratory and classroom. These are very tentative points of view based on comments that have been made to us.

While the syllabus does emphasize attitudes, we consider that there are considerable difficulties to be overcome. Not only do we have to ask how does one teach attitudes explicitly, if at all, but also how does one identify attitudes and evaluate them?

Such problems will be exercising our minds as one aspect of the Learning in Science Project. Your views on the points made in this essay, and comments and ideas related to the questions of the last paragraph will be gratefully received by us. We look forward to hearing from you!